

Title: Marginally Stable Nuclear Burning

Abstract: Thermonuclear X-ray bursts result from unstable nuclear burning of the material accreted on neutron stars in some low mass X-ray binaries (LMXBs). Theory predicts that close to the boundary of stability oscillatory burning can occur. This marginally stable regime has so far been identified in only a small number of sources. We present Rossi X-ray Timing Explorer (RXTE) observations of the bursting, high-inclination LMXB 4U 1323-619 that reveal for the first time in this source the signature of marginally stable burning. The source was observed during two successive RXTE orbits for approximately 5 ksec beginning at 10:14:01 UTC on March 28, 2011. Significant mHz quasi-periodic oscillations (QPO) at a frequency of 8.1 mHz are detected for approximately 1600 s from the beginning of the observation until the occurrence of a thermonuclear X-ray burst at 10:42:22 UTC. The mHz oscillations are not detected following the X-ray burst. The average fractional rms amplitude of the mHz QPOs is 6.4% (3 - 20 keV), and the amplitude increases to about 8% below 10 keV. This phenomenology is strikingly similar to that seen in the LMXB 4U 1636-53. Indeed, the frequency of the mHz QPOs in 4U 1323-619 prior to the X-ray burst is very similar to the transition frequency between mHz QPO and bursts found in 4U 1636-53 by Altamirano et al. (2008). These results strongly suggest that the observed QPOs in 4U 1323-619 are, like those in 4U 1636-53, due to marginally stable nuclear burning. We also explore the dependence of the energy spectrum on the oscillation phase, and we place the present observations within the context of the spectral evolution of the accretion-powered flux from the source.